# Influence of Landscape Restoration and Degradation on Storm Surge and Waves

***Planning Community of Practice Conference 2008***

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# Objective

- Demonstrate how a numerical modeling system can be applied to address planning challenges related coastal storm damage reduction projects and changing coastal landscapes.
  - Changing Landscape:  Erosion, subsidence, sea level rise, sediment supply, habitat switching, etc….
  - Mainland coast, barrier islands, wetlands

# Storm Surge and Wetlands

- Complicated Dynamics preclude application of simple “rules of thumb” (i.e. X miles of marsh reduces surge by Y feet – the old way of doing things)
  - Storm track
  - Storm intensity
  - Surrounding topography/bathymetry
  - Vegetation type

- Modeling is a tool for qualitative and/or semi-quantitative evaluation of the surge/wave reduction potential of coastal landscape features.

- Model is valuable for identifying trends and evaluating the relative performance of different features or alternatives

# Storm Surge and Wetlands

## Why the limitations?

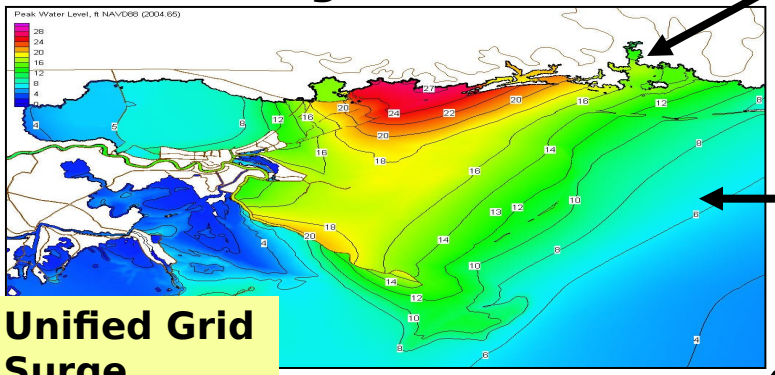
- New application of the model and area of active research.
  - Complicated physics
  - Representation of physical system
  - Friction factors
- Very limited data.
  - Need to fund research for field and laboratory studies

# Modeling System

- IPET
- FEMA
- LaCPR
- MsCIP

- Extensively reviewed - including the National Academy of Sciences

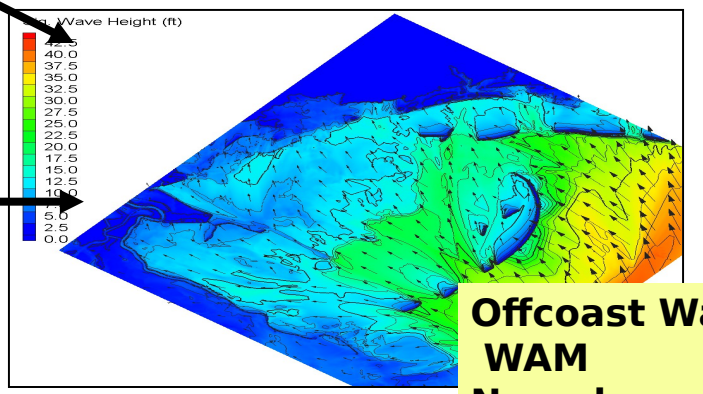
**Surge Model**



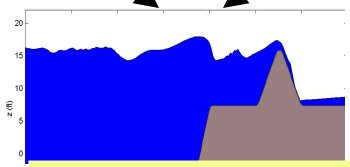

**Unified Grid Surge model: ADCIRC**

**Coupling**

**Wave Models**

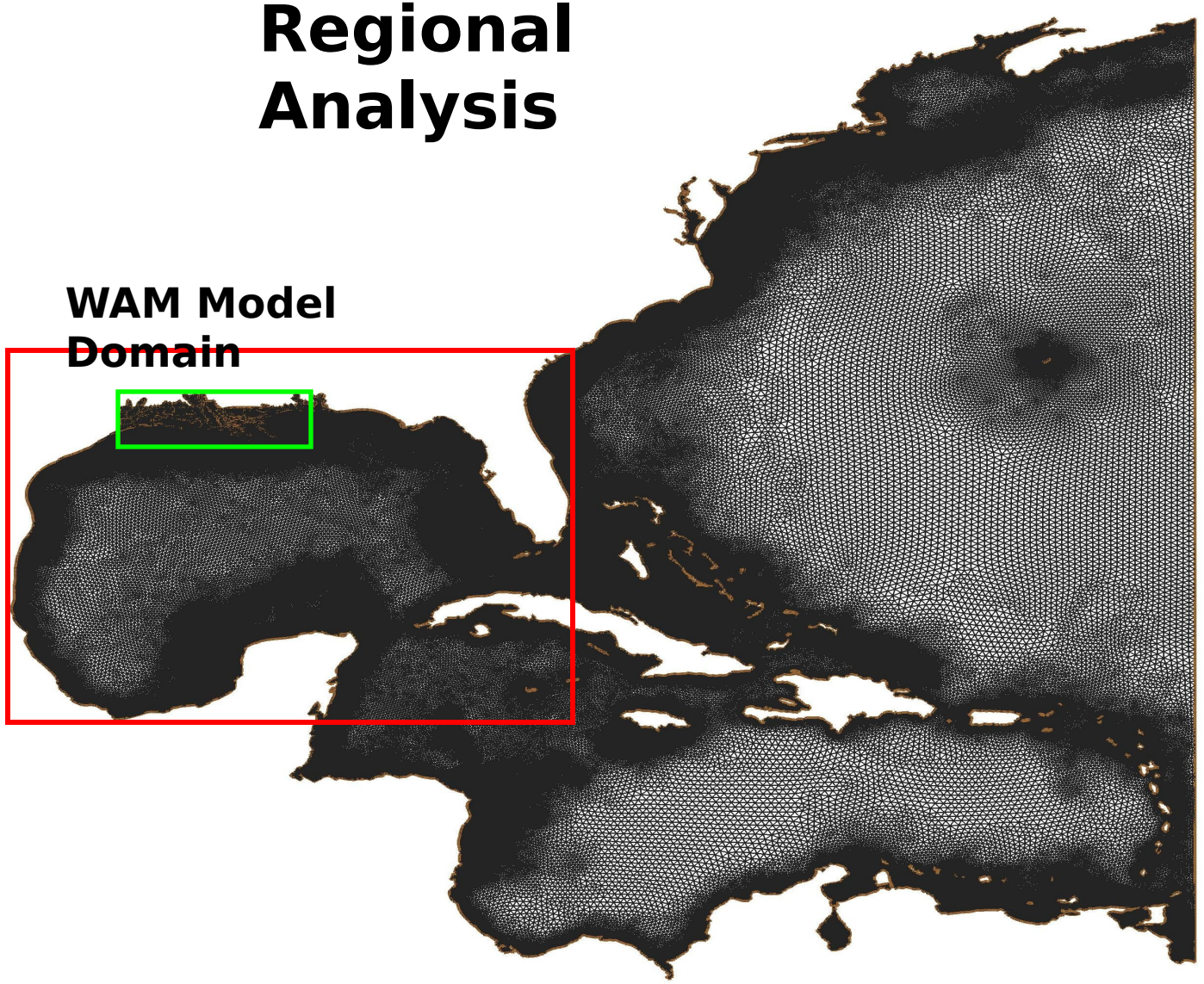



**Offcoast Waves: WAM**
**Nearshore Waves: STWAVE**

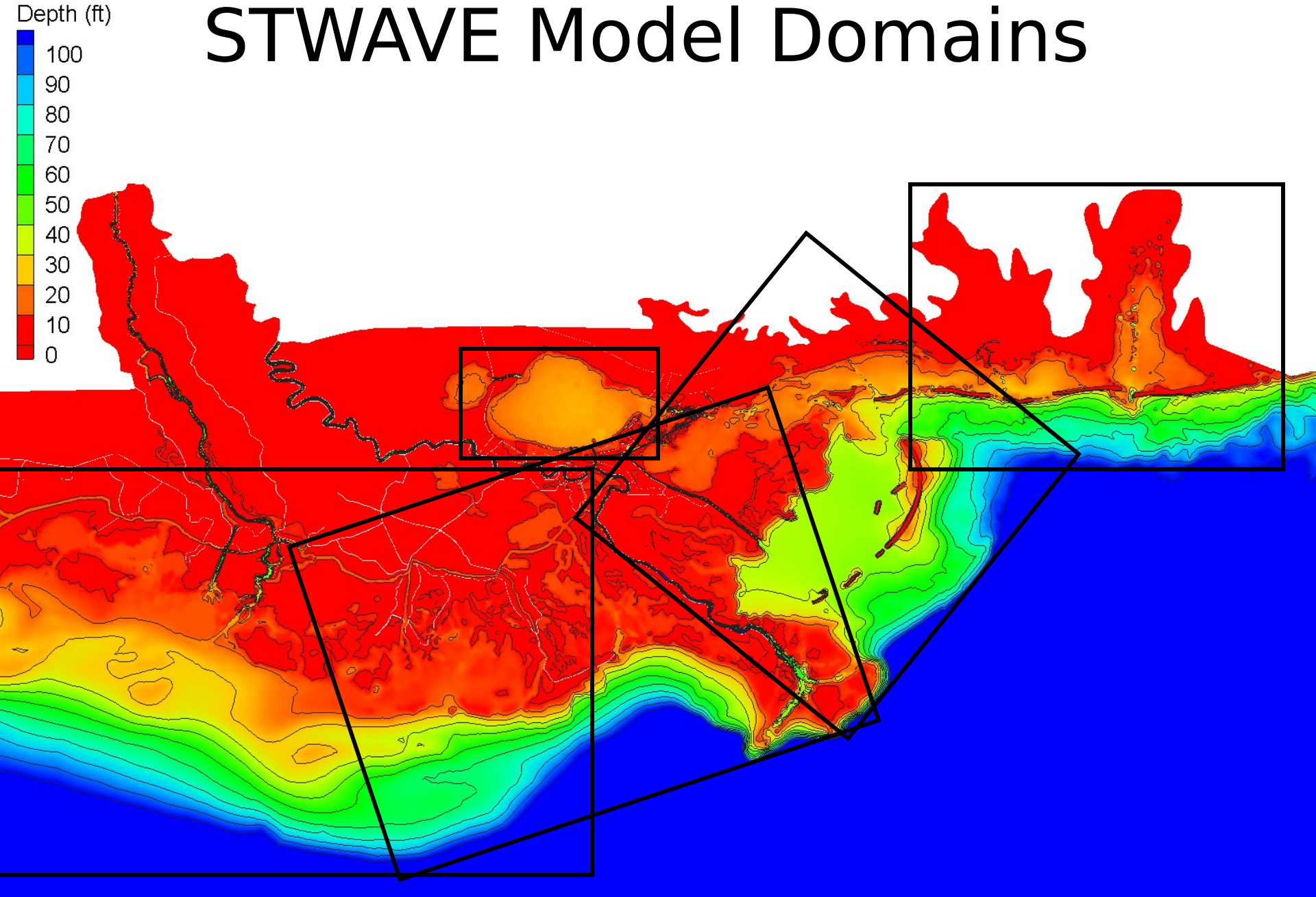


**Local Scale Waves: Boussinesq - Parametric**

# ADCIRC Grid Domain



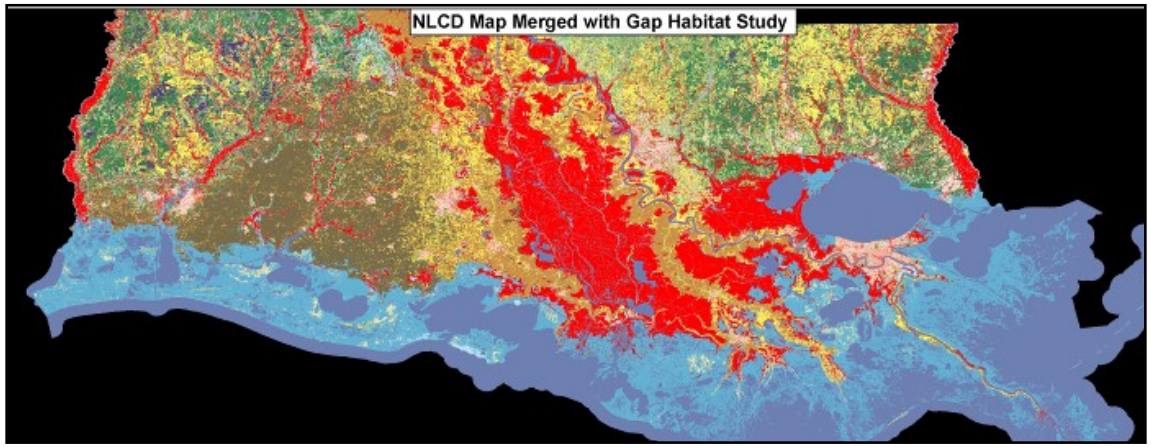
# STWAVE Model Domains



# Storm Surge and Landscape Features

- Considered:
  - Bathymetry and topography modify storm surge and waves.
  - Vegetation (land cover) reduces surface winds and slows surge propagation .
- Not Considered:
  - Changes to the landscape that occur during storms passage (i.e. vegetation stripped, land mass eroded)
  - Changes in the structure of the hurricane itself due to landfall infilling phenomenon that may be influenced by landscape features

# Land Cover Parameterization

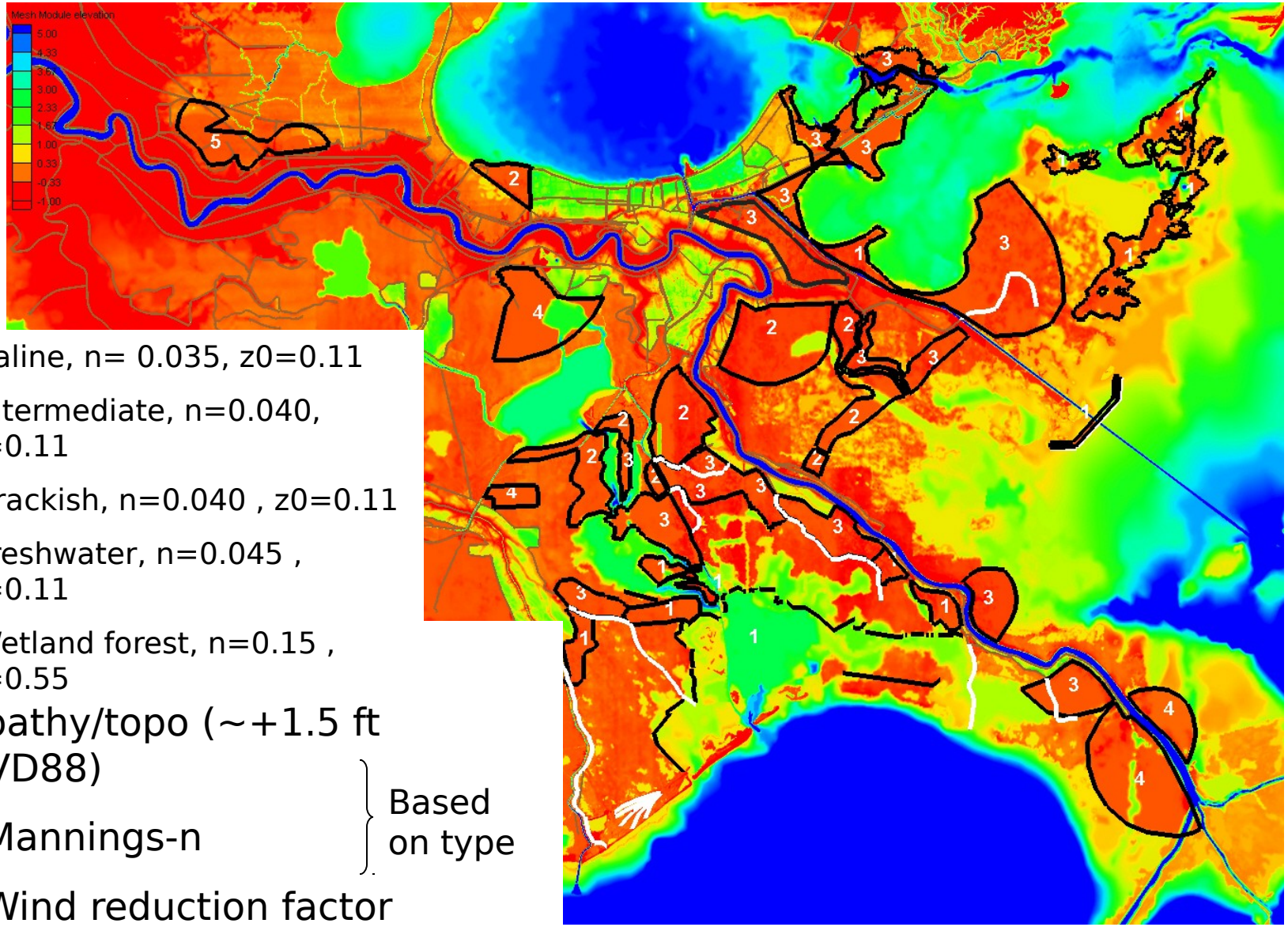



**Manning-n values for Louisiana GAP classes:**

**n = 0.055 ! fresh marsh**
**n = 0.050 ! intermediate marsh**
**n = 0.045 ! brackish marsh**
**n = 0.035 ! saline marsh**
**n = 0.15 ! wetland forest - mixed**
**n = 0.17 ! upland forest - mixed**
**n = 0.18 ! dense pine thicket**
**n = 0.020 ! water**

- Manning-n scalar parameterization used
  - Defined at appropriate grid scale
  - Base on published values
  - Validated against hindcasts of hurricanes Katrina and Rita

# Restored Landscape




1-Saline, n= 0.035, z0=0.11

2-Intermediate, n=0.040, z0=0.11

3-Brackish, n=0.040 , z0=0.11

4-Freshwater, n=0.045 , z0=0.11

5-Wetland forest, n=0.15 , z0=0.55

- bathy/topo (~+1.5 ft NAVD88)
- Mannings-n
- Wind reduction factor

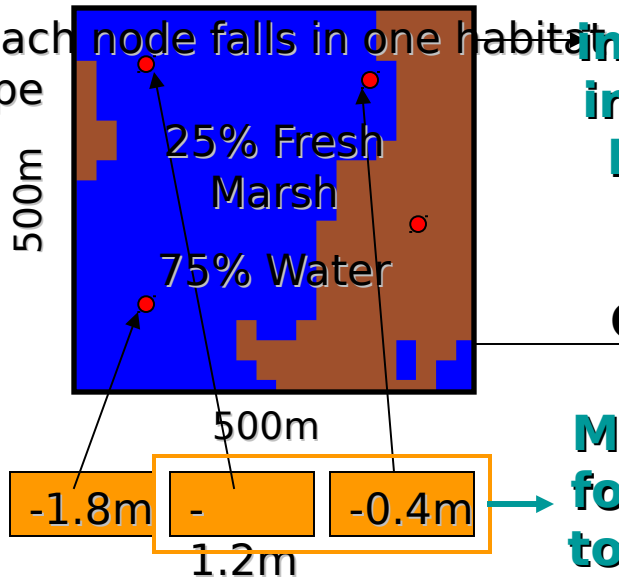
} Based on type

# Future Degraded Coastal Landscape
## CLEAR Output => ADCIRC

Bathy/Topo/Friction

**CLEAR Input Cell Year 0**

- LULC Data at 25m Res
- Each node falls in one habitat type




**50% increase in Fresh Marsh**

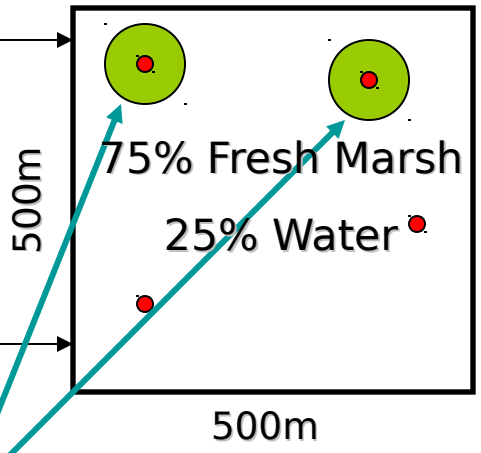
**2 water nodes need to change to Fresh Marsh**

**CLEAR 50 Yr Model Run**

**Most likely candidates for change from water to fresh marsh as they were the shallowest nodes in Year 0**

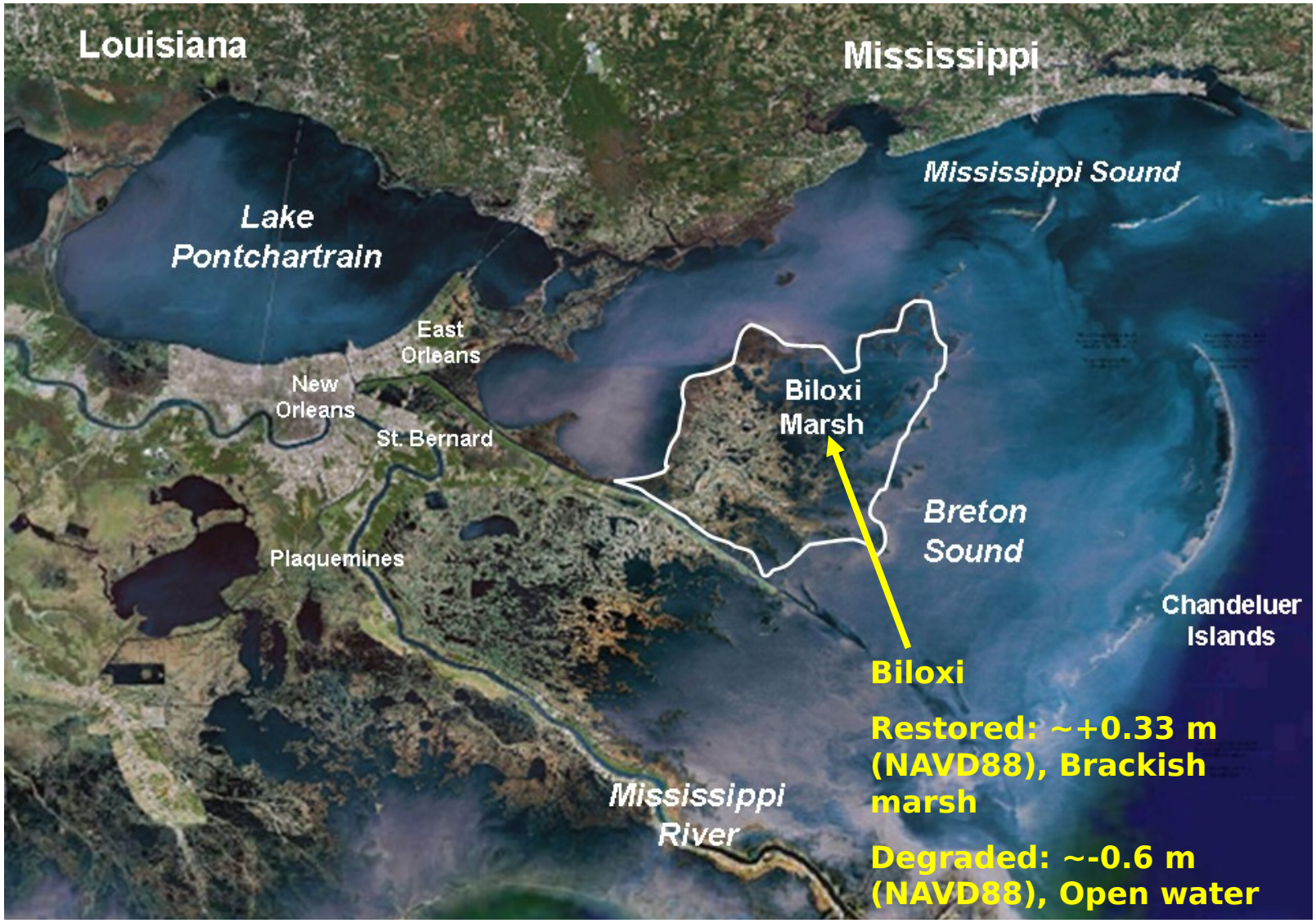
**CLEAR Output Cell Year 50**

- Spatial uncertainty




CLEAR => Coastal Louisiana Ecosystem Assessment and Restoration

# Wetland Restoration/Degradation



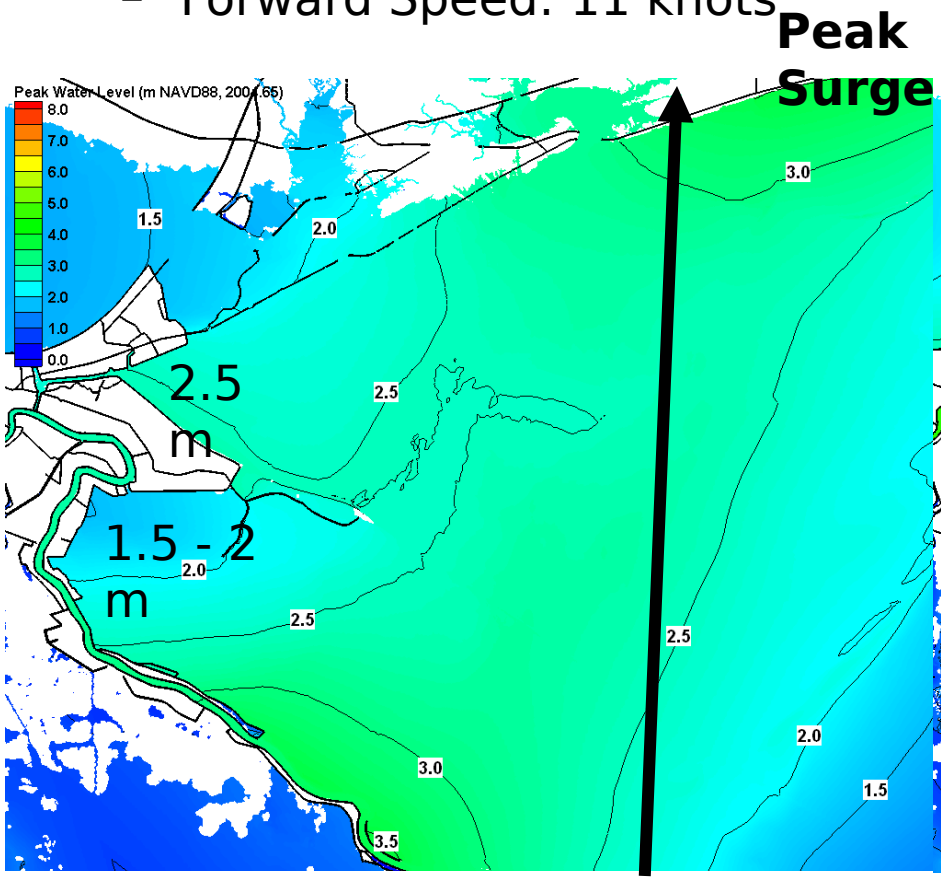
# Sensitivity Storms

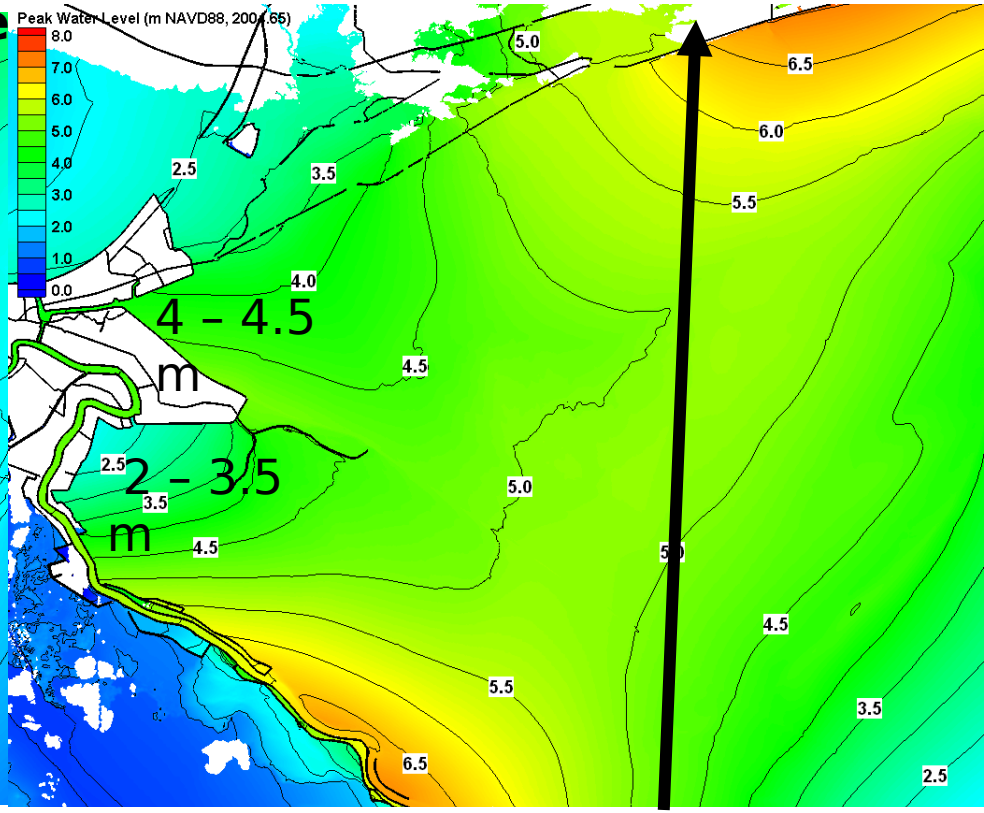
HUR1 (Hurricane Hilda-like)

- Central Pressure:  960 mb
- Rmax: 22 nm
- Forward Speed: 11 knots

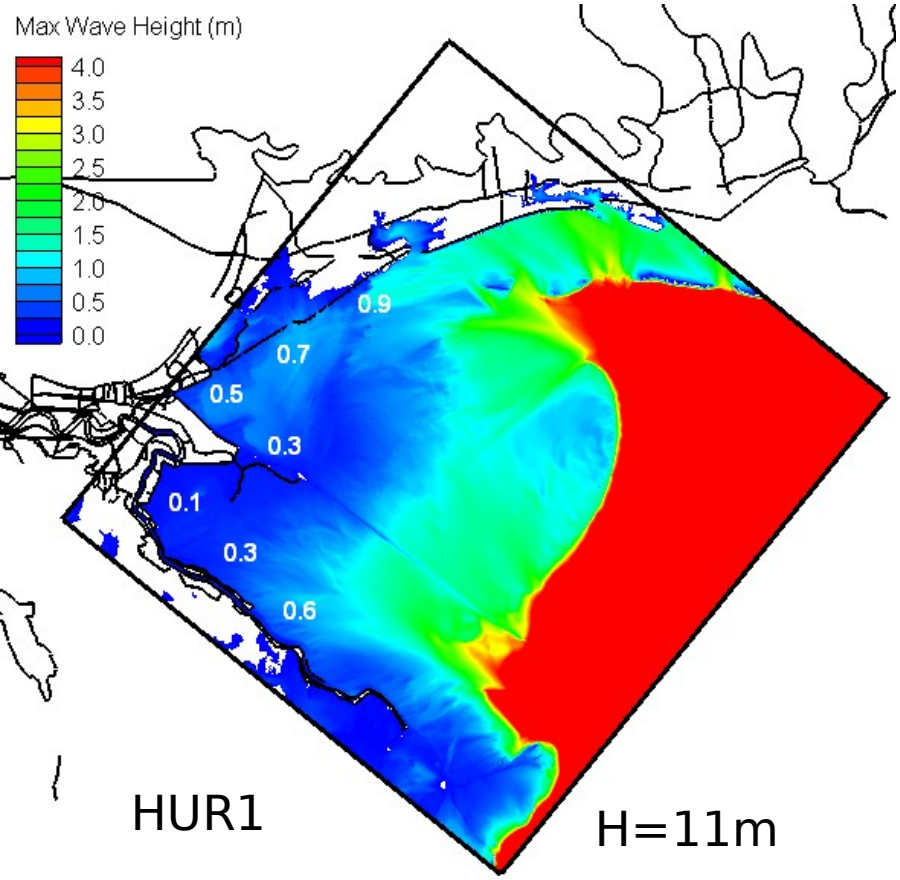
HUR2 (Hurricane Katrina-like)

- **Central Pressure: 900 mb**
- **Rmax: 22 nm**
- **Forward Speed: 11 knots**



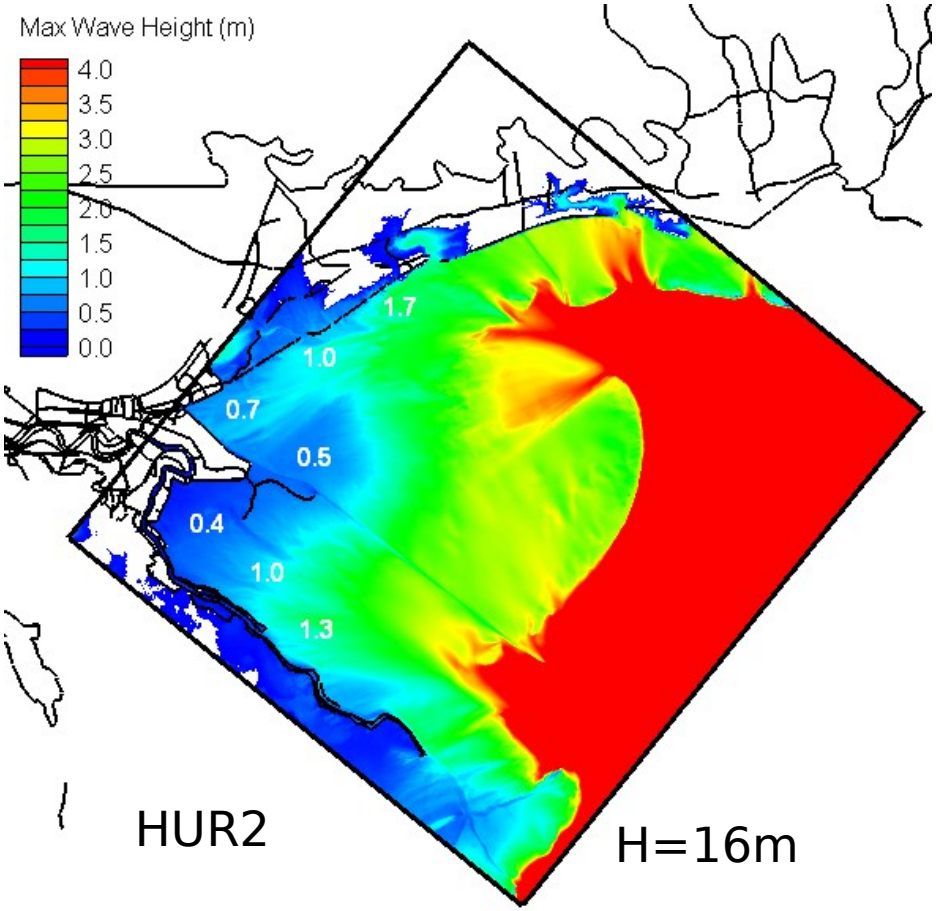



# Max Wave Height




HUR1

H=11m

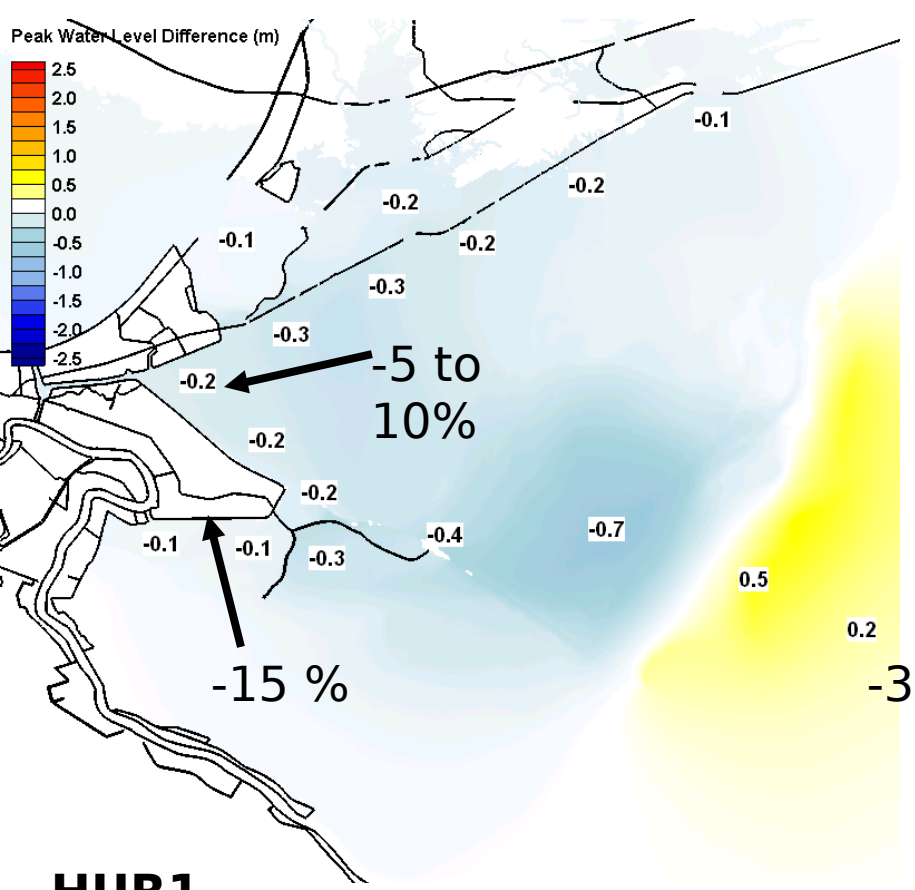


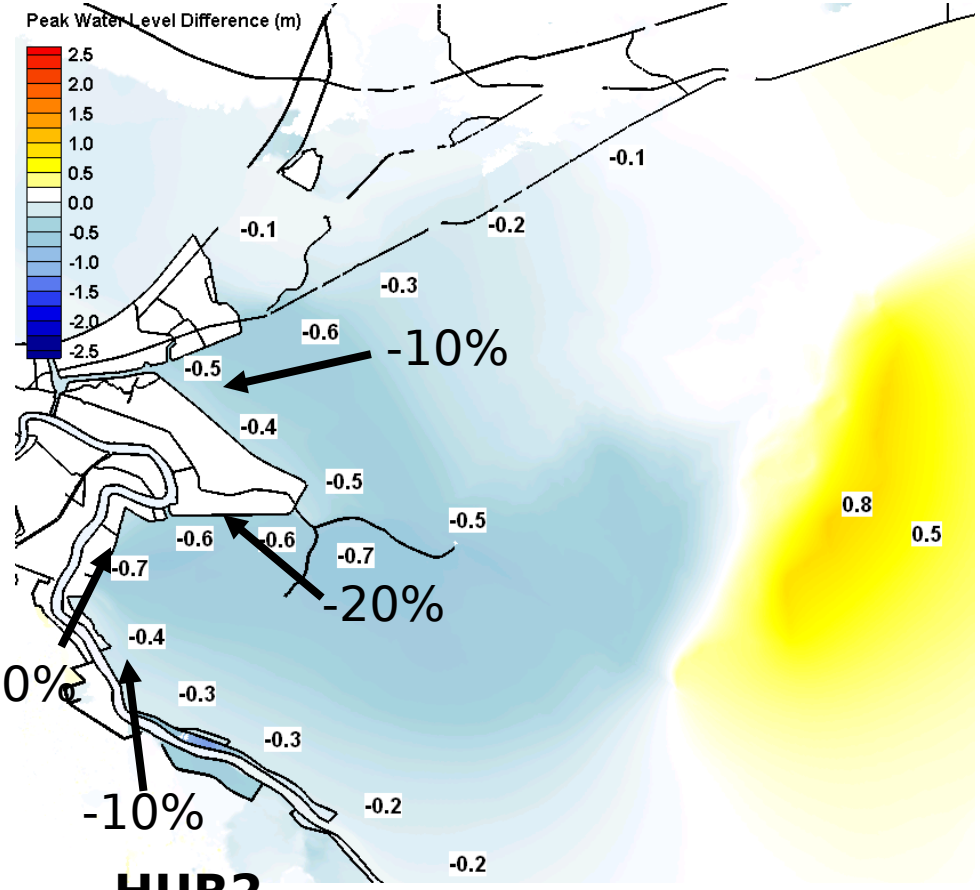

HUR2

H=16m

# Biloxi Restoration

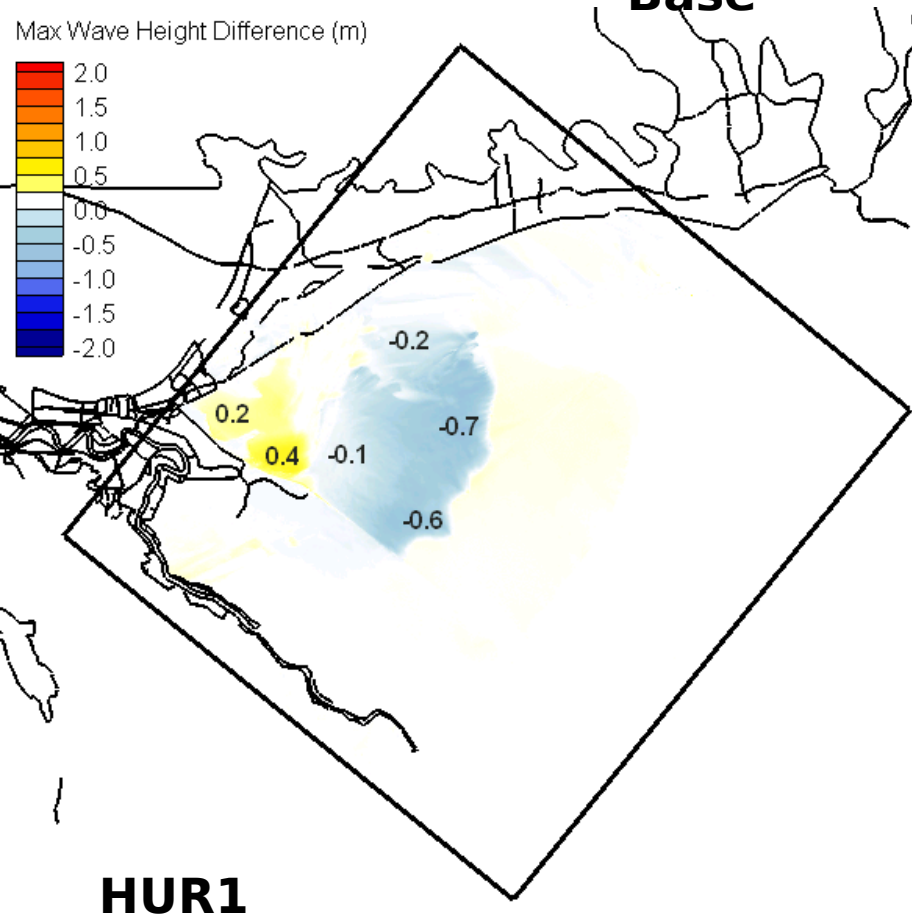
**Surge: Restored - Base**



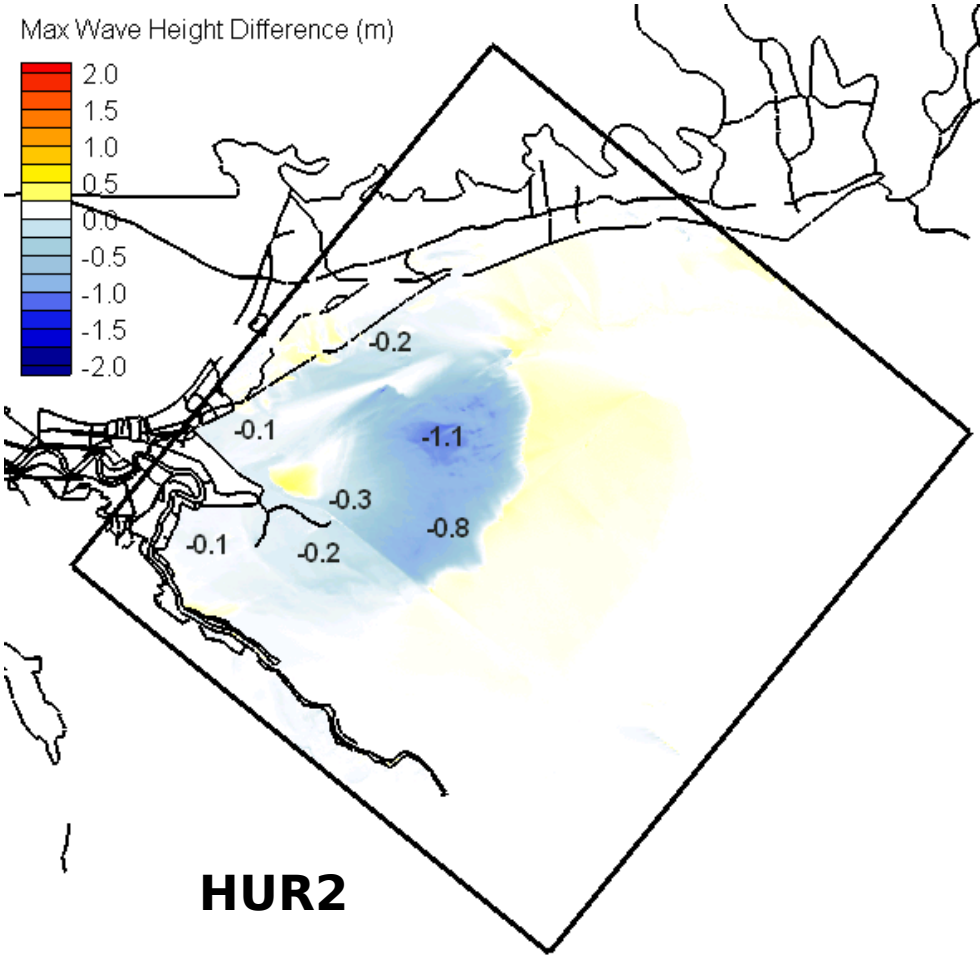



# Biloxi Restoration

**Waves: Restored - Base**



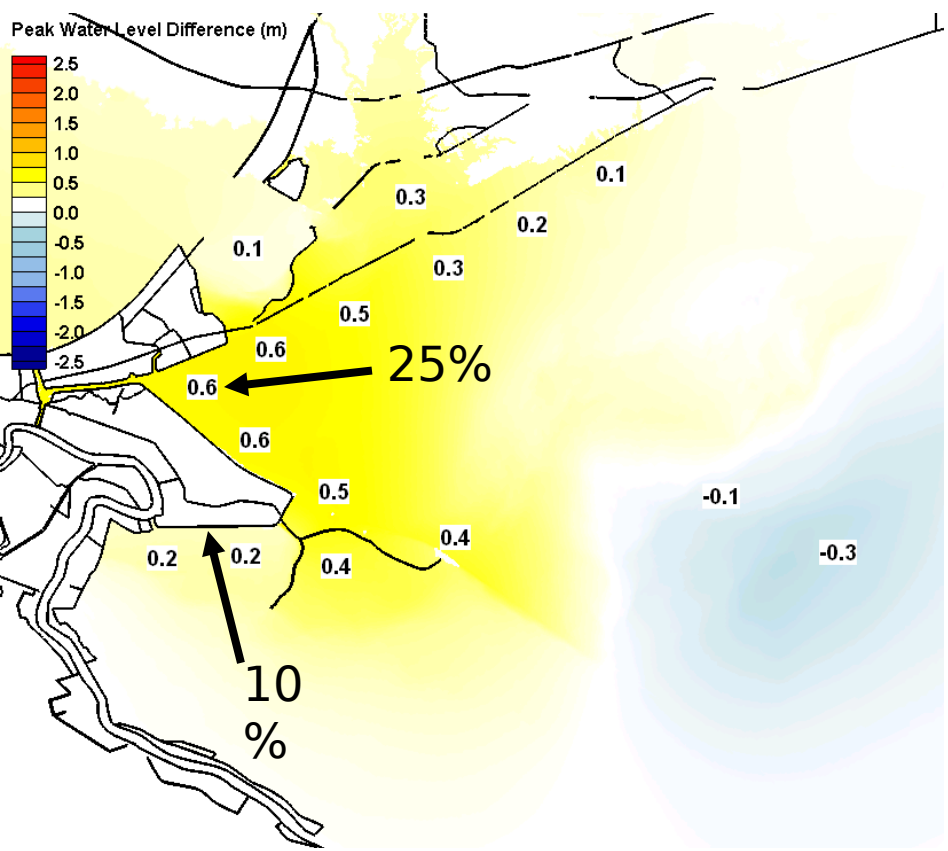

**HUR1**



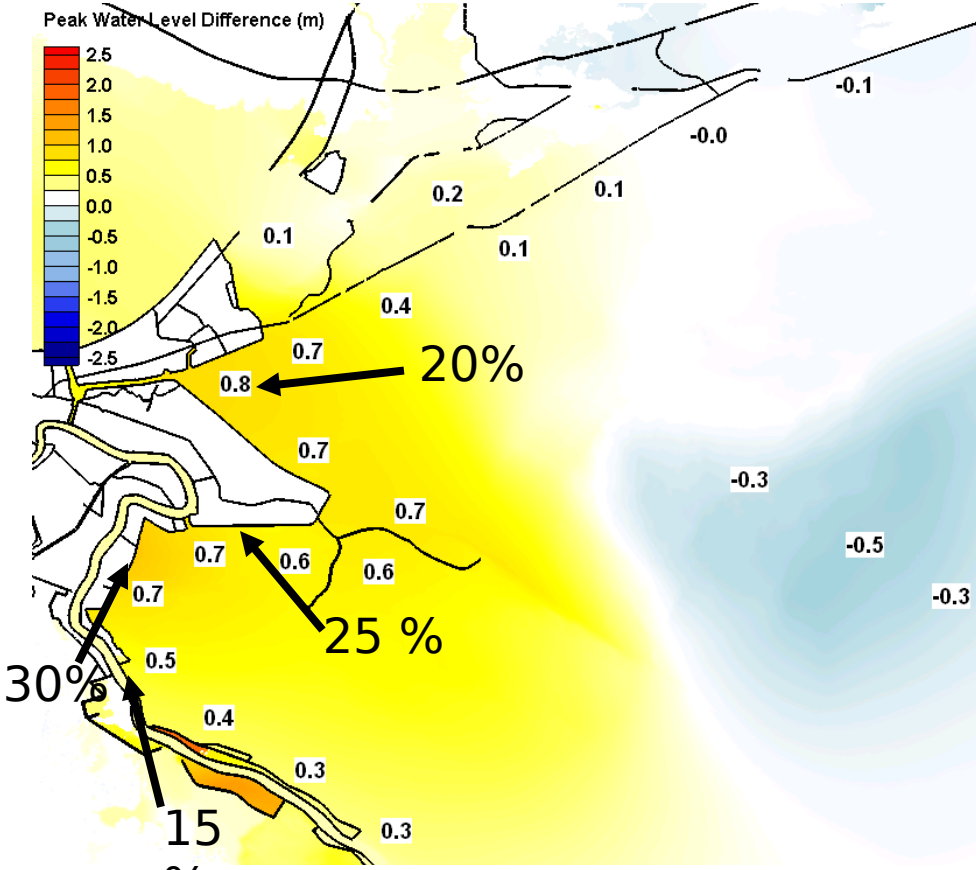

**HUR2**

# Biloxi Degradation

**Surge: Degraded - Base**



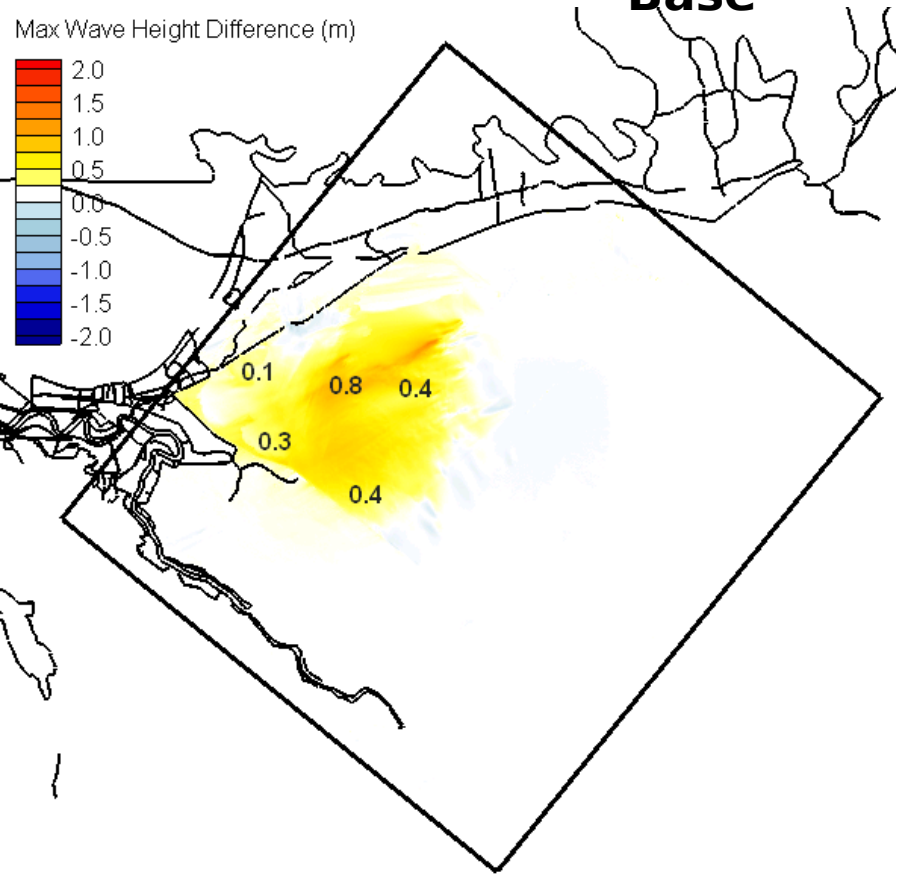

**HUR1**



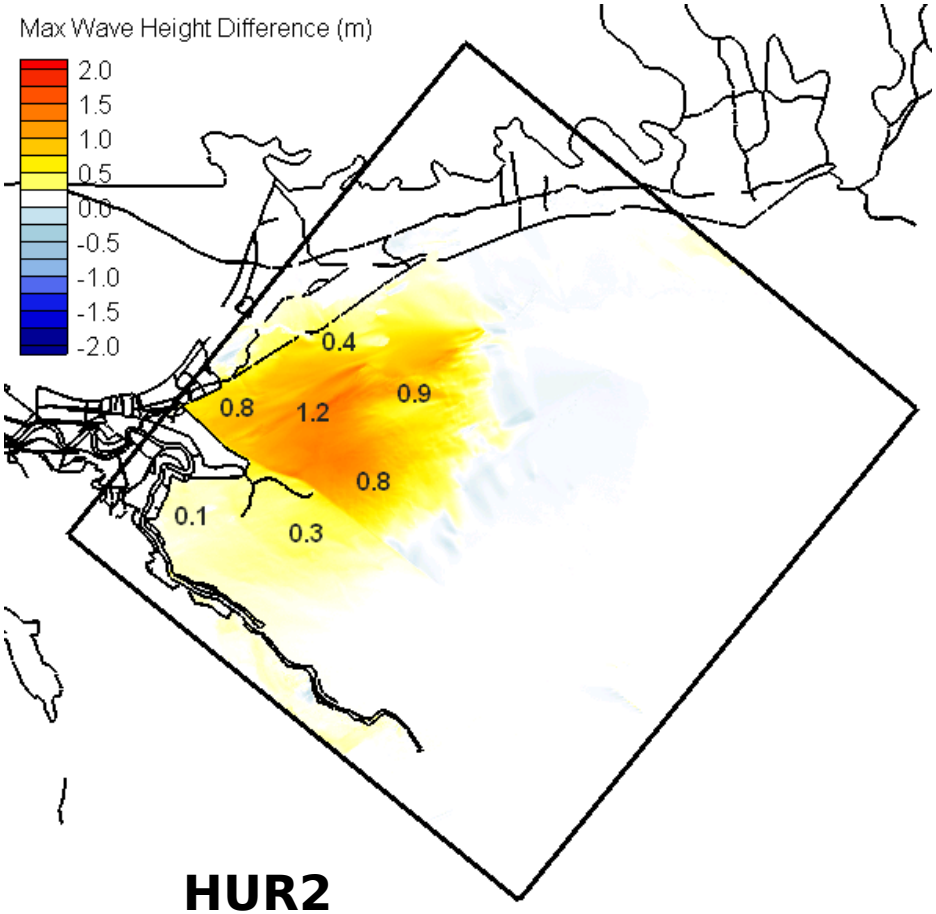

**HUR2**

# Biloxi Degradation

**Waves: Degraded - Base**




**HUR1**




**HUR2**

# Key Takeaway Points

- Changing landscapes should be considered in the planning process (i.e. sea level rise, wetland degradation, barrier island deterioration, etc.).
- The modeling system presented can be applied to make valid comparisons of future conditions and alternatives.
- The regional model allows for a “systems analysis” (i.e. unintended consequences far from project site, natural system influences on engineered system, etc.).
- Additional R&D is needed to improve our predictive  capabilities.

End